Jan Vymazal *Editor*

The Role of Natural and Constructed Wetlands in Nutrient Cycling and Retention on the Landscape

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Preface

The first workshop bearing the title "Nutrient Cycling in Natural and Constructed Wetlands" was organized at Třeboň, South Bohemia, in September 1995. The major organizing principle was to bring together scientists and researchers dealing with both natural and constructed wetlands; the majority of previous wetland conferences and seminars on these topics had been held separately. The first edition of this seminar was attended mostly by people dealing with constructed wetlands, but over the years, natural wetlands had become an increasingly substantial part of this workshop. The joint meeting has proven to be beneficial for both groups as interaction of natural and constructed wetland researchers is still limited. The International Water Association conferences on constructed wetlands and WETPOL conferences are usually not attended by many natural wetland researchers, while the Society of Wetland Scientists and INTECOL WETLANDS conferences mostly deal with natural wetlands. We believe that the interactions fostered by communication among all wetland researchers will continue to be a benefit for the full community.

The eighth meeting of this series took place again at Třeboň on May 17–22, 2013, this time entitled "The Role of Natural and Constructed Wetlands in Nutrient Cycling and Retention on the Landscape." The workshop was attended by participants from 17 countries in Europe, North America, and Australia. This volume contains a selection from the papers presented during the workshop —the first part of the book is mostly devoted to natural wetlands, while the second part deals with the use of constructed wetlands for wastewater treatment.

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Photo: Ketil Haarstad

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Contents

Chapter 1
Biomass Production in Permanent Wet Grasslands Dominated with *Phalaris arundinacea*: Case Study of the Třeboň Basin Biosphere Reserve, Czech Republic

Hana Čížková, Jana Rychterová, Libuše Hamadejová, Karel Suchý, Monika Filipová, Jan Květ, and Neil O. Anderson

Abstract *Phalaris arundinacea* is a highly productive perennial grass which inhabits both natural and human-affected wetlands. Along with natural genotypes, there are a number of cultivars bred for fodder production, especially in cool climatic areas. At present *P. arundinacea* is being investigated as a potential energy crop. Use of seminatural and natural stands of *P. arundinacea* as an energy resource requires a knowledge of the variation of aboveground biomass production, which forms the agricultural yield. This work gives an overview of long-term investigation of the production of *P. arundinacea* on various types of natural biotopes. It also presents results of a detailed field experiment assessing the effects of various management (cutting frequency, mulching, fertilizing) on the production of aboveground biomass in a seminatural wetland dominated by *P. arundinacea*. The results confirm that monodominant stands of *P. arundinacea* attain a high production in Central Europe. The seasonal maximum of aboveground biomass of natural stands ranged from 4 to 14 metric tonnes dry weight per hectare ($t.ha^{-1}$) with an average of 9.5 t ha^{-1}. Among the management types, the lowest annual agricultural yield of 4.1 t ha^{-1} (dry weight) was found in the treatment one cut per year and no fertilization. The maximum yield of 11 t ha^{-1} was achieved under three cuts per year and fertilization with a double dose of N and single doses of P and K. Two cuts

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per year and fertilization by P and K seem to combine the production and non-production functions in an optimum way.

Keywords Aboveground biomass • Energy crop • Wetland • Yield

1.1 Introduction

Phalaris arundinacea L. (reed canary grass) is a highly productive, C3 cool season perennial grass naturally occurring in floodplains and other wetland biotopes of temperate climates (Merigliano and Lesica 1998). Due to its high biomass production and tolerance of fairly harsh climates, it has been used as a forage crop in areas of northern Europe and North America (Galatowitsch et al. 1999; Merigliano and Lesica 1998). The species is also used as a perennial cover in pastures (Casler et al. 1998; Hoveland 1992; Kading and Kreil 1990; Riesterer et al. 2000) and as a mixture or pure stand forage crop (Buxton et al. 1998; Ostrem 1988; Sheaffer and Marten 1992). Forage cultivars low in alkaloid content have been bred and introduced as commercial cultivars (Coulman 1995; Coulman et al. 1977; Ostrem 1987; Narasimhalu et al. 1995; Wittenberg et al. 1992).

Shoreline restoration and revegetation programmes have planted *Phalaris* (Figiel et al. 1995). Soil and water restoration projects have used *Phalaris* for phytoremediation: impoundment of acid slurries (Olsen and Chong 1991) and soil contaminant removal (Lasat et al. 1997; Samecka-Cymerman and Kempers 2001; Chekol et al. 2002). Wastewater treatment facilities have also employed *Phalaris* for removal of N forms (Groffman et al. 1991; Sikora et al. 1995; Vymazal 1995, 2001; Zhu and Sikora 1995).

Recently *P. arundinacea* has attracted attention also as a potential bioenergy crop (Burvall 1997; Hadders and Olsson 1997; Hallam et al. 2001; Lewandowski et al. 2003; Nilsson and Hansson 2001) and is currently in production for this purpose in Finland and Sweden (Lewandowski and Schmidt 2006). Its fresh and ensilaged biomass can be used for biogas production (Prochnow et al. 2009). Dry biomass can be used for burning both separately and in combination with coal, as feedstock for thermochemical processes such as pyrolysis and gasification to produce methanol, synthesis gas and pyrolysis oils and for biochemical processes (fermentation and anaerobic digestion) to produce ethanol or methane (Hallam et al. 2001). It can also be used as a short fibre raw material for the pulp and paper industry (Finell 2003; Hellqvist et al. 2003; Papatheofanous et al. 1995; Saijonkari-Pahkala 2001).

Phalaris arundinacea is native to Europe, North and Eastern Asia and, to a limited extent, in North America (Merigliano and Lesica 1998). Only a few, non-aggressive populations of *Phalaris* are native in North America – predating European settlements (Merigliano and Lesica 1998). *Phalaris arundinacea* was introduced to North America in the 1850s (Lavergne and Molofsky 2004), although Merigliano and Lesica (1998) noted herbarium specimens from 1825 that